JULY 6, 1960

GAS IN INDUSTRY

Supplement to the "GAS JOURNAL"

Vol. 3 No. 26

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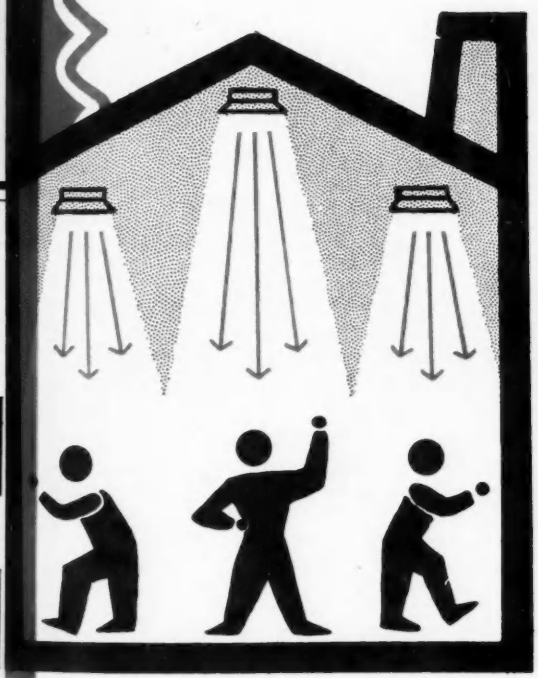

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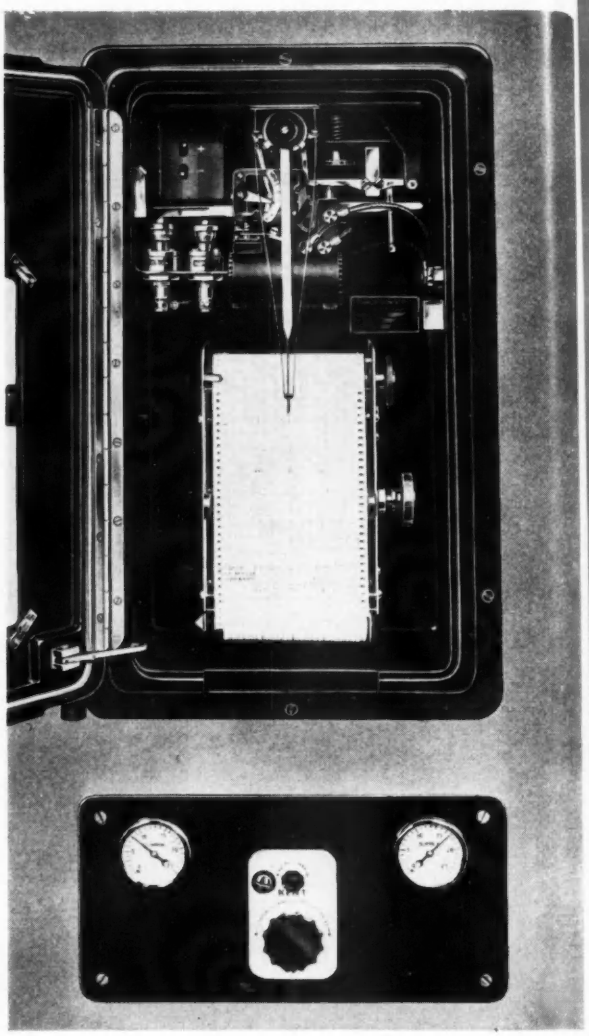

The SIGMA-KENT Wobbe-Index Controller maintains the Wobbe-Index value (calorific value/$\sqrt{}$ specific gravity) of an air-gas mixture at a predetermined level, irrespective of incoming-gas characteristics. An example of a direct-heating application where a stable flame characteristic is vitally necessary can be found in the extremely intricate operations of glass working in electric-lamp manufacture ; but there are other processes where control of Wobbe Index may be successfully applied to combat fluctuations in gas density and therefore in its burning properties.

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GAS IN INDUSTRY

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Vol. 3 No. 26

FEATURES

CLEAR AIR IN THE POTTERIES — ANOTHER REVOLUTION BROUGHT BY GAS

By Eric Ford

FACTORY KITCHENS — THE THIRD OF A NEW SERIES ON INDUSTRIAL CANTEENS

By 'GAStronome'

SCOTLAND'S INDUSTRIAL GAS

By A. Higgs and A. R. Dean

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Editorial

Service to Glasgow industry

THERE can be little doubt that a well-organised industrial gas engineers' department can solve most of the specialised problems confronting both the gas boards and the industrial user. This has once more been brought home to us in the paper 'The Development of the Industrial Gas Load in Scotland' by Mr. A. Higgs, Area Industrial Gas Sales Development Officer and Mr. R. W. Deans, the Glasgow and Western Divisional Industrial Gas Sales Officer, both of the Scottish Gas Board, which was presented at the recent meeting of the I.G.E. at Edinburgh.

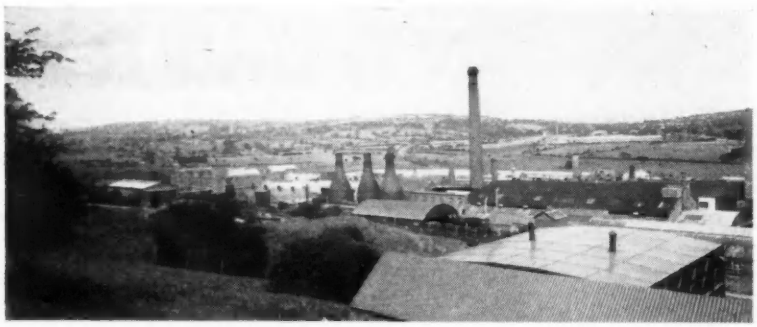
Scotland's industrial belt is in the area immediately surrounding Glasgow, so it is not surprising that the industrial organisation headquarters is in Glasgow and that the enterprise and drive behind the whole set-up comes from Mr. H. R. Hart, Deputy Chairman of the Board, at the same time General Manager of the Glasgow and Western Division. Other divisions of the Board, though clearly not so interested in the industrial load have each a divisional industrial gas officer and either two or three industrial representatives. This may seem a small establishment to exploit adequately the large divisional areas of this Board, but it is fair, we think, if it is realised that the industrial load is generally to be found in urban districts.

Perhaps one of the most striking things to be learnt from this paper is the outstanding contribution gas firing can make to heavy industry. Many of its applications to be found in recent papers have been to comparatively small plant, the drying of foundry moulds or ladles or the successful heat treatment of metals, but in Scotland we hear of its application to very large forge work, the soaking of heavy steel components and their fabrication in gas-fired furnaces of the largest size. The gas consumptions in the furnaces at William Beardmore's works are fantastic, and a recent conversion is said by the authors to add an extra consumption of 1,500 mill. cu.ft. of gas a year, equal for instance to the output of the Southport gasworks. These are very large loads, and it speaks well, we feel, for the energy and drive, as well as the technical 'know-how' with which the industrialists in Western Scotland have been approached.

Most of the examples described have been conversions from other fuels, and the ease with which this can be done is an excellent argument in favour of gas firing. For the industrialist is unlikely to be willing to install new gas-fired furnaces, however great their operating advantages, if there is still a number of years' life remaining in the existing plant. Conversions are a solution, but at the same time they make possible a very big build-up in gas load.

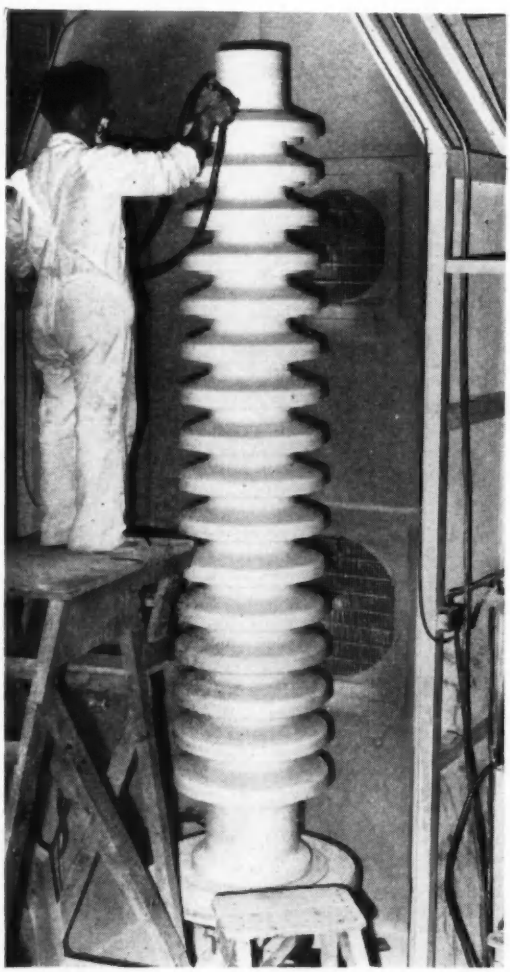
The industrial gas engineer would be the first to admit that a specially designed furnace would be even more satisfactory and efficient, so this places additional responsibility on the boards to give every assistance in the design of all gas-fired industrial plant. Such an organisation as we read of in the paper has been equipped for this very purpose, and will be able to follow its successful installations with more efficient specially designed plant in the future.

THIS CLEAR AIR AND THESE SMOKELESS CHIMNEYS



A general view of the works of Bullers Ltd. The pall of smoke formerly associated with the Potteries is entirely absent, due largely to the introduction of gas-fired equipment.

One example of the gas revolution in the Potteries



Components of this size and shape pose special problems of drying and firing but gas-fired equipment is equal to the job.

By ERIC FORD

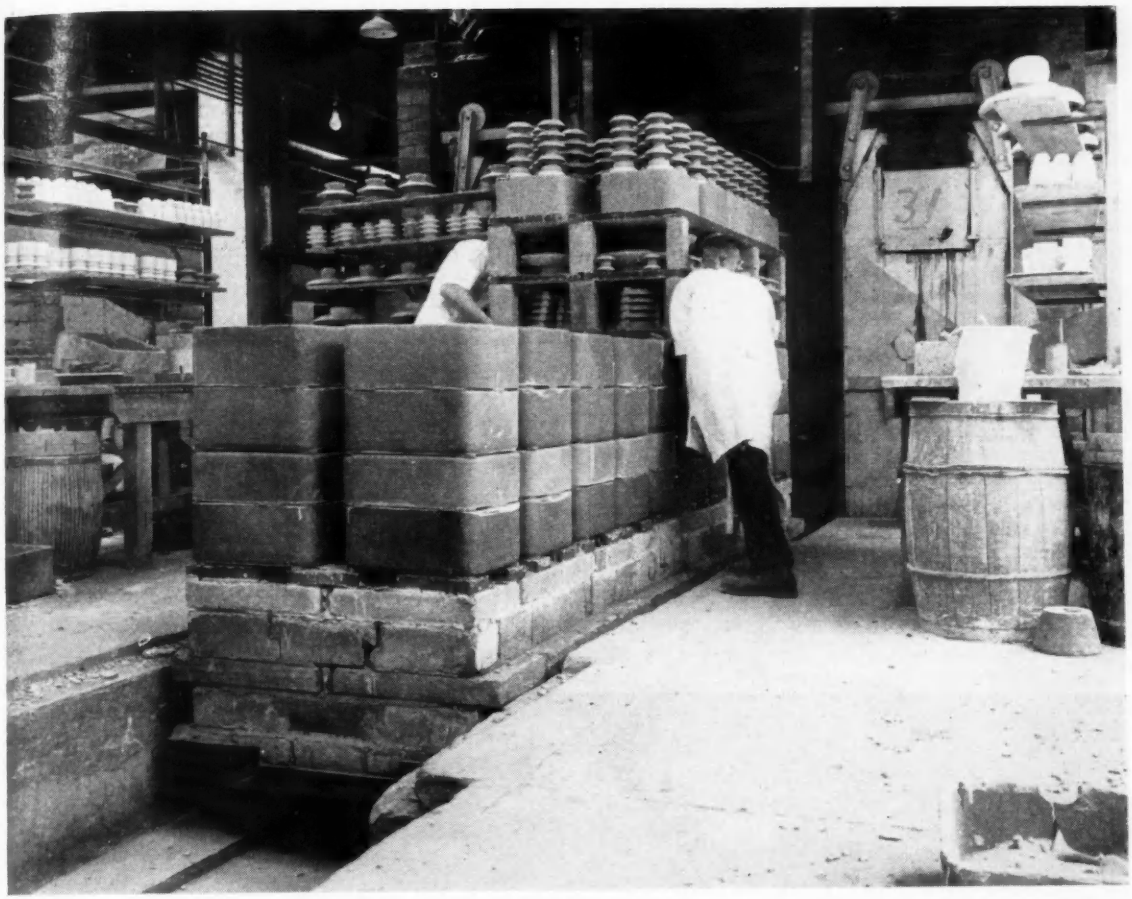
ELECTRICITY supply and utilisation depend upon efficient insulators, which may range from very small items used in the radio and electronic industries to huge components required for heavy duty service in such applications as power supply and railway electrification. Of the various materials which are used for electrical insulation purposes, porcelain is probably the best known and certainly the most effective.

Staffordshire in general, and Stoke-on-Trent in particular, are rightly recognised as the home of the best china and porcelain and it is therefore not surprising that Bullers Ltd., one of Britain's leading manufacturers in this field, have their works at Milton, Stoke-on-Trent.

Important consumer

The company, which is particularly well-known for the production of larger forms of electrical porcelain, is an important consumer of gas, taking some 320 mill. cu.ft. a year from the North Staffordshire Division of the West Midlands Gas Board.

In general, heat is used in the pottery industry for drying the raw material at various stages in the production process and for the firing of the final product. Very careful control of heating processes is necessary because at several points close limits of moisture content must be observed. Both technical and economic considerations point to gas as the most suitable form of fuel for the pottery industry, particularly when advantage is taken of the latest developments in gas-fired equipment,



Firing ovens include both tunnel types (continuous) and intermittent ovens (batch-type). In the tunnel oven, the ware is stacked on special trolleys running on rails through the oven. A load of insulating material is shown here about to enter the 300-ft. long oven.

as is the case at the plant of Bullers Ltd.

Electrical porcelain manufacture follows the same lines as the production of any other vitreous body, with special emphasis on the development of a really strong ceramic, as demanded by the nature of this particular end-use. The main raw materials are china clay from Cornwall, ball clay from Devon and Dorset and felspar and quartz from Scandinavia. The processes of extracting some of these materials require the use of water and some drying may have taken place before the materials reach the factory.

China clay and ball clay are mixed with water and stirred until the clays are broken down to a very fine grain size, in suspension in water. Felspar and quartz, which are received as large lumps of rock, are crushed and ground in cylinders with water until they, too, are in the form of minute particles in suspension in water.

These basic constituents in 'slop' form are then run together in the quantities necessary to produce a body containing raw materials in the correct proportions for the product in question.

Jollying process

In this state, the material is too wet to be worked and it is therefore passed to a filter-press for water removal. It leaves the press with a moisture content of about 22% and is now ready for forming into the required shapes by a process known as 'jollying'. The first stage of this process is to pass the material through a pug mill whence it emerges in a long ribbon-like shape reminiscent of tooth-paste many times magnified. In this form, it is 'jollied' to the required shape by means of an interesting process in which the skill of the craftsman plays an important part. This is, in fact, one of the most highly-skilled jobs in the industry.

Jollying techniques are used mainly for the production of cap and pin insulators used for suspension and tension on the high voltage national grid system. Jollying also produces the post insulators used on high voltage switchgear and the large transformer bushings.

Other types of insulating materials, such as low voltage distribution insulators, railway electrification insulators, both overhead and 'third rail' and a great variety of large and small cylindrical and tubular insulators, are produced by a different process in which the final shape is produced by turning the material on a lathe. In this case, the material is dried in gas-fired ovens to 7—8% moisture content, prior to turning.

After turning, these components are ready for the important drying process but insulators which have been jollied have first to be removed from the plaster-of-paris moulds. This is effected by drying in a gentle heat, in the course of which the plaster-of-paris attracts the moisture from the material. As a result, the insulator contracts slightly and can be lifted from the

mould. For this reason, the insulator in its clay state will be considerably larger than the final desired size, to allow for this contraction. It is interesting to note, for instance, that a 10-ft.-high transformer bushing is made 11 ft. 3 in. high in the clay state.

Whether turned or jollied, the insulators are subjected to similar procedures from now onwards, the first of which is drying to white hardness. The correct drying of ware is a particularly important process and the recent striking improvements which have followed the introduction of gas as a source of heat in this process are well illustrated by the equipment in use at Bullers Ltd. It is in this field that gas has been found particularly sutable and gas-fired equipment, both of the continuous and the batch type, has made considerable advances throughout the Potteries.

Formerly, Bullers Ltd. employed the conventional method of drying in the pottery industry, namely, a brick room of suitable size, heated by steam or hot water pipes supplied from solid fuel-fired boilers. Average temperatures in the region of 96°F. were achieved and the drying time, which necessarily varied considerably with the type of article, ranged from three to 14 days. As the rooms were also used as passageways, the amount of traffic through them during normal working hours meant that considerable heat losses occurred.

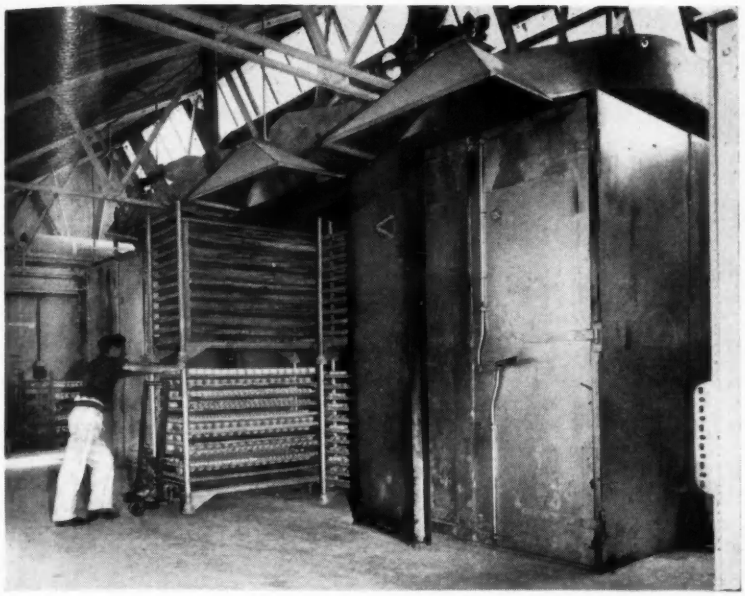
One of the first improvements undertaken was to convert the solid fuel boilers to gas firing and although this produced some economies, the drying time remained unchanged. It was thus obvious that a more fundamental solution must be sought and steps were taken to install a recirculating, gas-fired oven. A prototype of this oven had already been built by Casburt Ltd., Fenton, Stoke-on-Trent and this formed the basis of the production model which was eventually installed in the Bullers Ltd. works.

On the basis of this design, and as the result of close and fruitful co-operation between Bullers Ltd., Casburt Ltd. and the West Midlands Gas Board, a production-size oven was built which proved immediately satisfactory. A number of these drying ovens have now been installed in the works, giving greatly improved drying times, reduced labour costs, better working conditions and a more even drying of the ware. The new drying plant also occupies less space and this has proved an important factor in effecting certain factory alterations.

Drying of electrical porcelain poses particularly difficult problems. The materal to be dried is sometimes as much as 9 in. thick in cross section and the great diversity of shape and section also raises difficulties in drying. Furthermore, the smallest hair crack caused by uneven drying will lead to failure at the testing stage. This problem was very much in the minds of the designers and manufacturers of the ovens now installed at Bullers Ltd. for drying purposes.

These ovens are of the double-cased

All ware requires to be dried at some stage of its manufacture and this battery of ovens is typical of the equipment used at Bullers Ltd. Considerable economies have been secured compared with former methods.



Loading an old-type drying oven was a lengthy and laborious business. The simplicity and ease of the present system is obvious from this view of a drying oven being charged with ware.

recirculating type in which the air movement is created by an axial flow type fan and spread by carefully balanced distribution ducts over the whole stove area, with intermediate ducts acting as compartment divisions. Ovens are divided into four compartments, each of which has its own damper system enabling partial or complete isolation. This permits work to be loaded or unloaded from one compartment while the rest of the oven operates at full production.

Return air ducts are connected from selected top positions to ensure uniformity of air and heat flow through the ware. The recirculation system is fully dampered and is complete with fresh air inlet slides, together with the gas heater induction system. The axial flow fan provides the combustion air and a small cool air duct prevents overheating of the fan motor, which is sited close to the burner. Humidity ducts are incorporated in the design and these are sited to lead from convenient positions on the drier to release accumulated moisture.

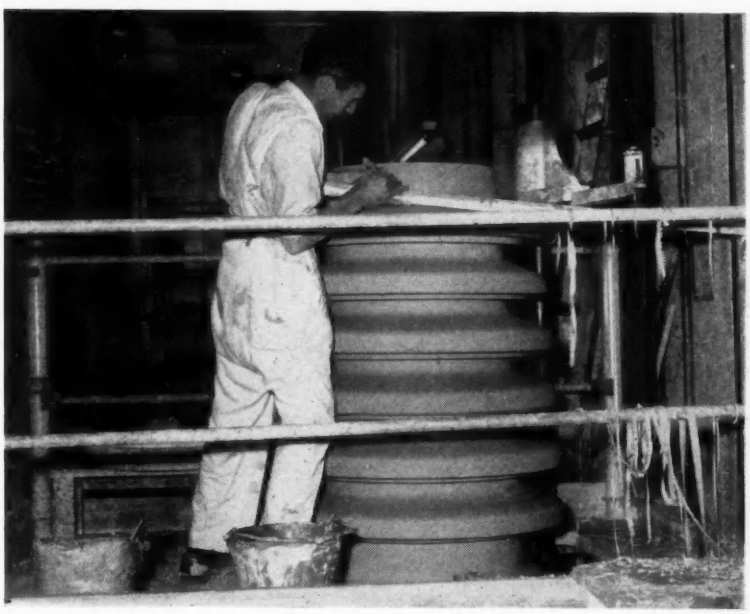
Remote control

Heating for these ovens is supplied by W.M.G.B. burners developed by the Industrial Department of the West Midlands Gas Board. The heaters are mounted on top of the ovens and have gas consumptions ranging from 600 to 900 cu.ft. per hour. They are fitted with Sperryn thermostatic control, flame failure equipment and a solenoid wired through the axial flow fan. Thermostatic control permits a temperature suitable for the particular article being dried and remote control is achieved through the axial flow fan starter switch.

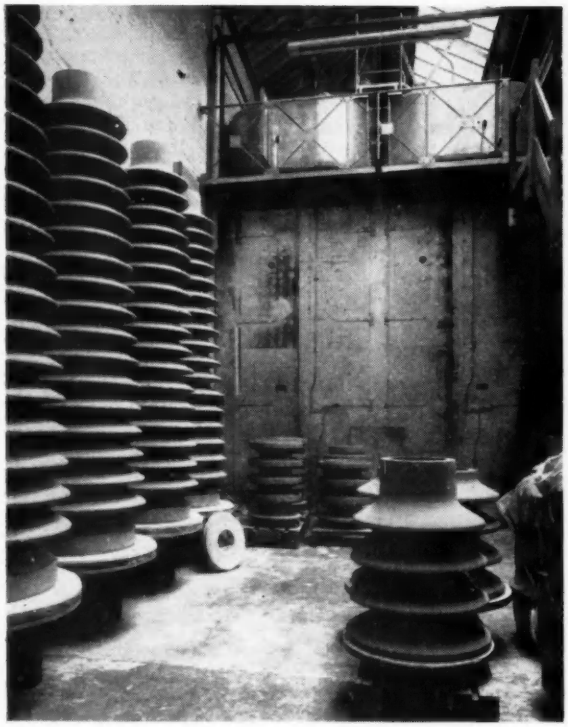
Operation of the ovens is on the batch principle. After turning, or jollying, the ware is placed on trolleys which are positioned two high by mechanical loader in preparation for pushing into the oven. The ware itself is on boards. Each oven compartment holds eight trolleys and the number of boards on each trolley depends on the type of insulator being dried. As many as 18 boards may be placed on a single trolley so that, since the trolleys enter the oven two at a time, it may be that 36 boards are loaded at once as compared with single-board loading under the former method. Process time varies with the product, but with the general run of production, two to four days' drying covers the range. The smallest low voltage insulators could be dried overnight, while with the biggest bushings, over which the company cannot afford to take any risks, a period of seven days in a special large dryer is allowed. Operating temperatures are in the region of 120-130°F.

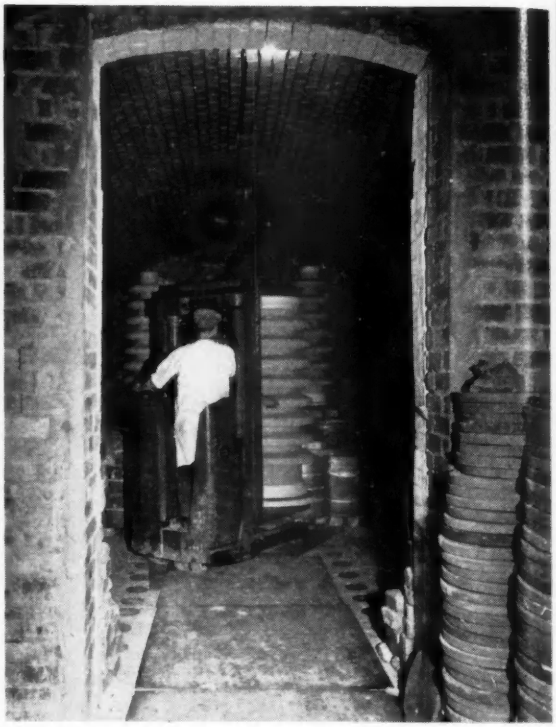
Drying times halved

By the use of these ovens, drying times have been more than halved and gas consumption savings have been remarkable. Examples given include the drying of h.t. suspension insulators for which the gas consumption per component was 81 cu.ft. under the former method (i.e., conventional brick-built compartment steam-heated by gas-fired boilers) compared with 13 cu.ft. with the present equipment. A similar comparison shows that rail



Although machinery is used wherever possible, there is still room for craftsmanship of a very high order in the manufacture of electrical porcelain. This operative is working on a transformer bushing.

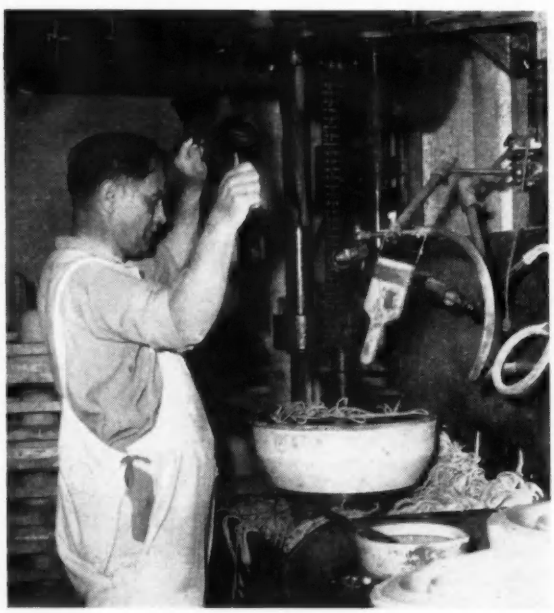




Left: *Special problems associated with the drying of large transformer bushings are met by the use of this large gas-fired oven.* **Right:** *Inside one of the large intermittent gas-fired kilns. Note the use of mechanical handling equipment for loading.*

track insulators required 66 cu.ft. per component under the former method and 5 cu.ft. now, while l.t. switches took 5.13 cu.ft. formely and 1.15 cu.ft. with the present equipment.

At Bullers Ltd., the drying ovens of this type which have been installed are capable of handling the wide range of articles now being produced. With the advent of higher voltages in the electrical industry and the increase in the size of transformer bushings, it has been found necessary to install driers capable of handling bushings up to 12 ft. in height.



Work in progress on the earlier stages of a 275 kV suspension insulator. This will later have to be dried, glazed and fired.

These components are made piece by piece, each section being jollied by skilled craftsmen and later stuck together. This is as fascinating to watch as it is difficult to perform, and to watch the various pieces being accurately placed one on top of another is an interesting experience. The pile of pieces rests on a base which rotates rapidly so that the bushing itself turns while the craftsman uses his hands to ensure that each separate component is correctly positioned and completely true.

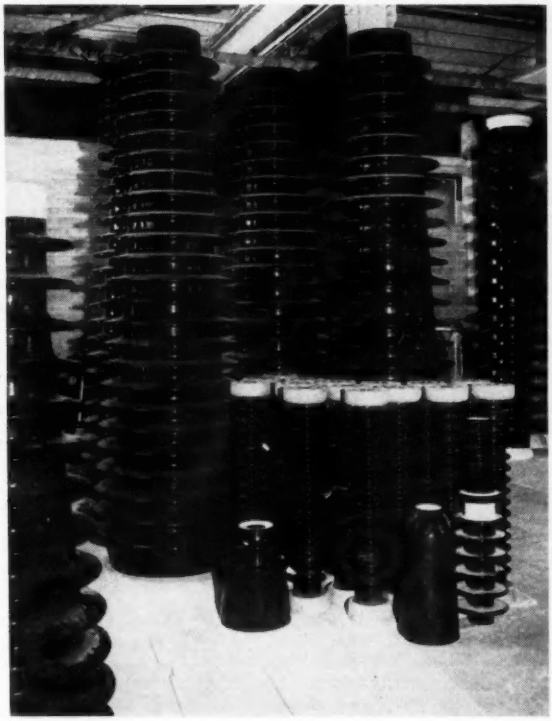
When this task is nearing completion, the result is of such accuracy that the bystander is unable to tell that the 12-ft.-high bushing is actually rotating.

After being dried to white hardness, these and all the other insulating materials have next to be fired, a process which demands considerably higher temperatures than drying. It was in the firing of porcelain that the famous bottle-shaped kilns traditionally associated with Stoke-on-Trent were, and in some cases still are, used.

On approaching Bullers Ltd. factory the visitor sees three of these bottle kilns rearing their familiar shapes up to the sky, but these are no longer in use and today stand only as eloquent reminders of the days before gas-fired equipment came into general use in the pottery industry. Today, at

Bullers Ltd., the firing of electrical porcelain is carried out in gas-fired tunnel ovens and batch-type gas-fired equipment, commonly called intermittent gas kilns.

Before entering the firing oven, the components are dipped in a vitreous material similar to that comprising the 'body' from which the components themselves are made. This may also contain an ingredient which gives the component its final colouring. The larger components, however, such as the transformer bushings which have to be assembled before drying, are too large for the dipping process and are therefore coated with the glazing material by aerograph spray.



British craftsmanship at its best! These fine examples of high-grade electrical porcelain are ready for use by the world's electrical industry.

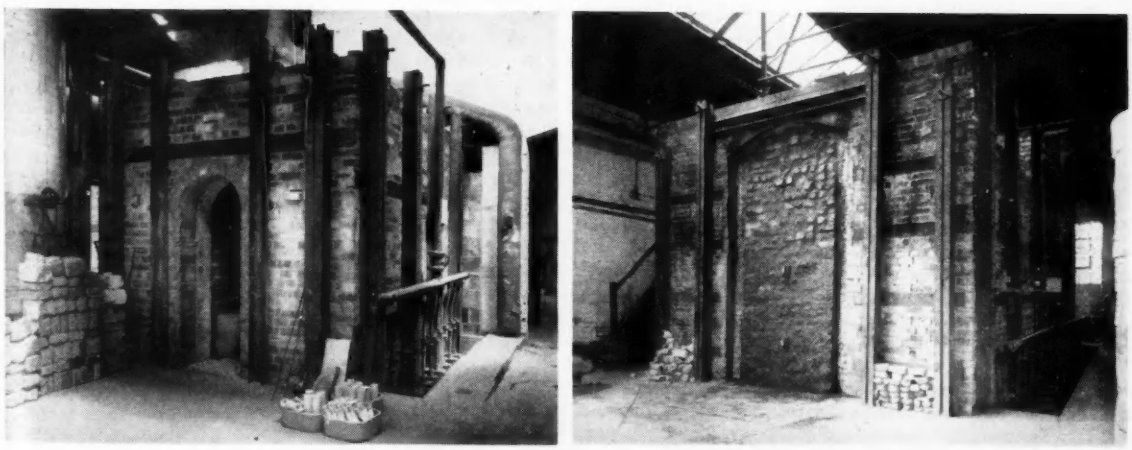
Firing components

At Bullers Ltd. the main tunnel for firing insulation components is some 300 ft. long and is divided into three zones, respectively a pre-heat zone, a firing zone and a cooling zone. Operating temperature in the firing zone is 1,260°C. and the complete cycle of pre-heat, firing and cooling occupies 67½ hours. The firing zone itself covers 90 ft. of the oven which possesses a considerable degree of flexibility. If at any time the company should be short of ware ready for firing the speed of the movement of ware through the oven is reduced and some of the burners cut out at each end, thus deriving the same heating effect from a shorter heating zone.

Pre-heat is of vital importance and the early treatment of the ware is effected by a recirculator which draws hot air from the top of the kiln and feeds it back at the entrance end to the bottom of the load. It is equally important to have an evenly distributed fall in temperature after the ultimate temperature has been reached. Extra burners are used to control this fall of temperature and thus prevent different rates of cooling on one piece of ware which would cause it to crack with considerable risk also to the components around it.

Tunnel kilns have the advantages of continuous operation as compared with the batch-type procedure of the old bottle kiln. A railway track runs through the oven on which the ware runs on specially designed cars. The ware itself is stacked in a kind of lidless box made of refractory material and known as a saggar. Bullers Ltd. however, are gradually cutting out the use of saggars in favour of the more modern technique of open firing in which the ware is placed on silicon carbide tiles.

By this means, considerably more material is placed in the kiln, although firing conditions have to be even more closely controlled as there is no saggar wall to protect the ware from heat shocks caused by variations in the firing. Whether saggars or tiles (open



Left: *A gas-fired kiln, showing the method of stacking the ware in readiness for firing. The box-like containers, are known as saggars.* **Right:** *a charge of ware is being fired inside this intermittent kiln. The burner arrangement and the method of sealing the entrance is clearly seen.*

firing) are used, by the time the cars on which they are loaded reach the end of the tunnel kiln, they are cool enough to handle.

Although the gas-fired tunnel kiln has many advantages over the traditional 'bottle', both economically and technically, it is necessary for these kilns to be run continuously at or near maximum payload conditions for full economies to be obtained. Owing to the prevailing economic conditions on the demand side of the pottery industry, it is sometimes necessary to have recourse to more flexible production conditions particularly for some lines, and for this reason a shorter tunnel oven or series of intermittent units are often used as complementary equipment to the large tunnel oven.

In any case, so far as Bullers Ltd. are concerned, there are certain items which are too large or of the wrong shape to be fired in the tunnel-type of kiln and for this reason, the Company's range of gas-fired kilns includes a number of the intermittent type. One such installation is particularly noteworthy. This is a large intermittent kiln with internal dimensions of 25-ft. by 14-ft. by 12-ft. high which is fired by 26 burners of the nozzle-mixing type, using town gas at normal mains pressure and air at approximately 6—8-in. w.g.

Even temperatures

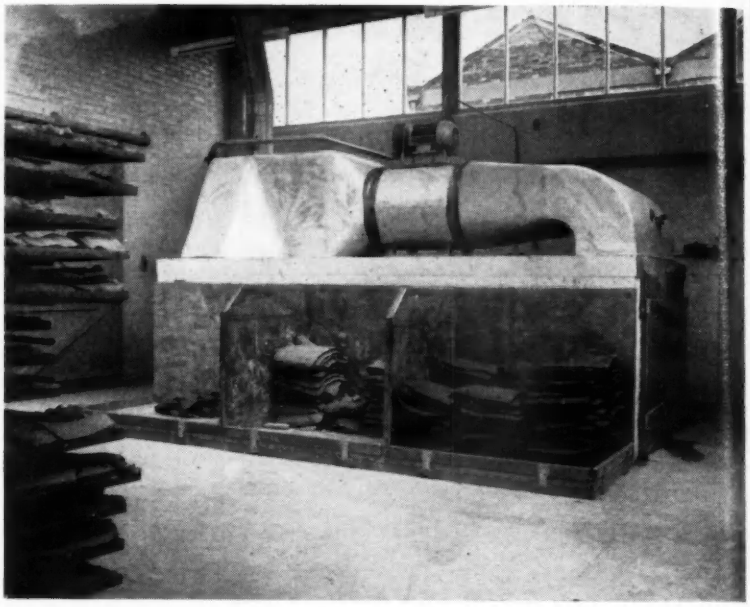
A kiln of this type reaches the peak temperature of 1,260°C. in approximately 60 hours and the complete firing cycle is about five days' duration.

Burners are sited low down on each side of the kiln and the products of combustion circulate via a series of flues designed to produce the very even temperatures necessary for producing the high quality of electrical porcelain for which Bullers Ltd. are well known.

Maximum gas rates in a kiln of this type will naturally depend on the type of work being processed but something of the order of 10,000 cu.ft. per hour can be expected at peak consumption. Total consumption for a full firing cycle of five days is approximately 400,000 cu.ft.

After firing, the insulators and components have completed their manufacturing process, although many insulators require certain fittings. These are made from malleable cast iron and galvanised at the company's Tipton (Staffs) foundry but fitted at the Milton works. These metal fittings are attached to the insulator by a cementing process, although some insulators are sold unfitted.

All insulators are subjected to stringent tests before leaving the works, either for sale on the home market or for export which absorbs quite a large proportion of Bullers' total production. Great attention is paid to testing, which takes place in a separate testing department where every insulator, large or small, is subjected to both electrical and mechanical tests. It is here that the quality of the heat treatment received at both the drying and firing stages is severely tested and the company reports that since the introduction of gas-fired equipment, rejections from this cause have substantially decreased.



Clay direct from the filter press at 22% moisture is dried in this gas-fired stove down to 10% moisture content. It is then granulated and used in the die pressing department for the production of small pieces of complicated shape for use in radios, cookers, refrigerators and other equipment.

It is interesting to note at this stage that not only do Bullers Ltd. apply these exhaustive tests to their products but they themselves also produce a piece of test equipment which is widely used throughout the pottery industry. This is the Bullers' Ring, a 2½-in. diameter annular ring of refractory material made in a closely-controlled body so as to contract a known amount for any given combination of time. and temperature in the kiln. These rings can be used in both continuous and intermittent kilns and, by drawing them out at intervals during the firing process and measuring them the operator can gauge how near to the correct conditions the kiln is for the particular type of ware under treatment.

As befits one of the first firms to install gas-fired tunnel ovens in the Potteries (this was in the early 1920's), Bullers Ltd, have been quick to see the virtues of gas for other purposes also. Space heating for almost the entire factory, which occupies a site of 22 acres, with 330,000 sq. ft. of factory floor space, is by gas and indeed, with upwards of 300 separate heaters, the factory has one of the largest gas-fired space heating installations in the Potteries. Overhead heaters by Bratt Colbran and Harris Engineering Ltd. have been installed. These give excellent results, being individually controlled.

An interesting point in regard to the heating system is that it has been found to have many advantages from the production point of view, as three examples will testify.

In the turning process, for instance, when the 'body' is in its plastic state after passing through the filter, it is a difficult matter to get the length of clay down to the required 8% moisture. If under these circumstances, the clay can be placed near an overhead heater, with a fan to keep the air moving, it has been found that the necessary delicately-controlled drying process can be achieved.

Another application of the space heating equipment to the production process is seen in the 'slip' house where the basic ingredients are mixed and ground. During cold weather, the clay is liable to freeze and crack but the use of overhead heaters is sufficiently effective to prevent this seasonal risk from occurring.

When the large transformer bushings are assembled and cemented to-

Continued on page 194

FACTORY KITCHENS — III

By 'GAStronome'

Estimating — a job for the gas industry

WHEN the industrialist decides to have his factory or office restaurant kitchens re-designed or re-equipped he will want to have an estimate of the costs, and a forecast of the potential life of the new project and the servicing charges likely to be incurred. This is best completed by an independent specialist independent of the equipment manufacturer who would quite naturally base the estimates on the products that his company markets.

The gas industry could well provide such a service. As a contribution towards such an end, this part of the series on factory kitchens will indicate the form this could take. It will deal with the re-equipping and design of a kitchen typical of any serving a good quality meal in a factory or an office building. Call them what you will—canteen restaurants or luncheon clubs—they are all basically the same, only differing in appointments.

A survey of establishments typical of the country show the greatest number to be in the 150-200 meal class. It is proposed to consider a restaurant of this size.

Design has already been mentioned in previous contributions, and the open design (as against the partitioned design) was recommended, on account of the ease of work, hygiene and economy it offered. Details of design will depend upon the particular kitchen with its own special problems and may be large or small. In re-designing it is important to study the original layout and to retain those parts that work smoothly and save heavy work. There is no point at all in re-designing for its own sake. On the other hand the opportunity is available to make the work of the kitchen easier. Study of operations will indicate in large measure the shape of things to come.

Several new trends

There are several new trends, as well as new hygiene laws and recommendations, that should be incorporated in the layout. Double sinks for dishwashing, personal hand washing basins, floor and wall materials, space around equipment for cleaning purposes and the latest washing-up materials, are some of the items to be considered.

The kitchen designer needs to keep abreast of all developments in equipment, gas cooking and food service appliances and electric-powered preparation machines. All systems of dishwashing, waste disposal and aids to kitchencraft should be known to him and brought into the scheme according to requirements. He should keep in mind the smaller items of equipment that do so much to make the work tick over smoothly.

Before estimating the cost of equipment it is necessary to set limits to what comes under the heading of 'kitchen design.' This would normally be everything from the goods entrance of the kitchen to the actual service of

Continued on p. 194

Catering for 250 meals a day - typical outlay

		£
Dry storage	Weighing scales 14 lb.	10
	4 storage bins on wheels	30
	Stacking racks 6 ft. 3 ft. widths	150
	6 ft. bench table with racks under	30
Vegetables	Open mesh three-tiered rack 6 ft. wide (on wheels)	50
Cold storage	30-cu. ft. refrigerator	200
Preparation	18 ft. of preparation bench with shelf under (or 3 ft. x 6 ft. tables)	90
	3 sinks	60
	Potato machine	50
	General purpose mixing machine with mincing and cutting attachments	130
	Meat slicing machine	110
	Potato chipping and mashing machine	50
Cooking	3-oven gas range	300
	1 single pan frying range	120
	1 steaming oven	140
	1 salamander	70
	1 stock pot stove	30
	1 open bain marie	100
	3 trolleys for kitchen use	60
Service of food	12 ft. of hotcupboard, the whole top fitted as bain marie containers with heated shelf over, glass protection and tray rail	560
	Cold counter with glass shelves over and fitted shelves under, 8 ft. in total length with tray rail	200
	Tea, coffee and milk set on stand, shelves for cups etc.	300
	Tray racks, cutlery boxes and 4 clearing trolleys	100
Wash up and waste disposal	Dishwashing machine of the tank and brush system with say 10 ft. tabling	800
	Waste disposal unit (water fed)	90
Pan washing and several waste disposal	Two tank pot washups with drainage tabling	100
	Pot rack on wheels	50
	Waste disposal unit (water fed)	90
	Incinerator	100
	2 waste bins	10
	Approximate costs of re-organising services. Associated decoration. Assembly, etc.	300
	Possible total	4,500

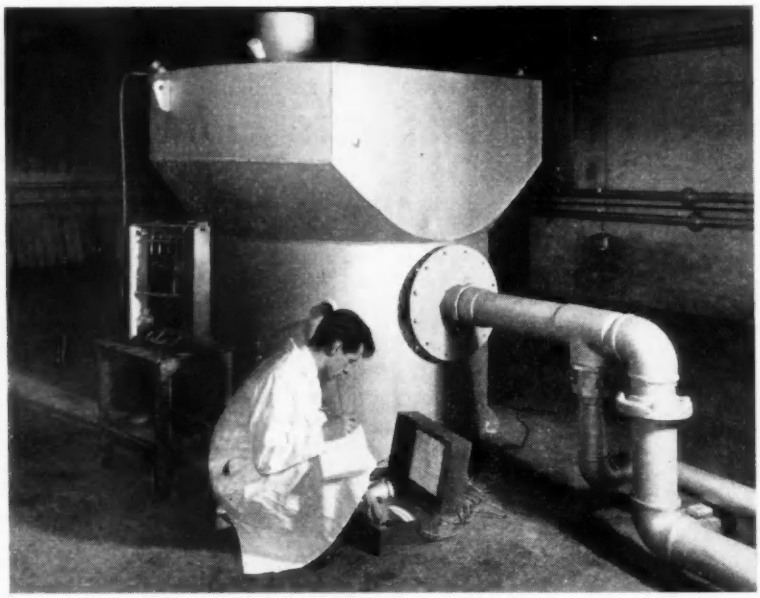


FIG. 1. *Combustion chamber of a Cochran packaged boiler under test in the laboratory.*

This paper to the Institution of Gas Engineers is of great topical importance as heavy industry emerges from its recession

Part 1

Scotland's industrial gas

THE industrial load of the Scottish Gas Board has shown an increase annually since vesting date, excepting for the years 1955 and, particularly, 1958-59, when the impact of the general trade recession was felt.

The trade recession still persists, in degree, in the shipbuilding and heavy engineering industries, but it is pleasing to record that new business, secured during the year ended March 31, 1960, has substantially cancelled out the decline, and, as heavy industry regains momentum, the upward trend is expected to accelerate.

Scotland has a fair cross-section from all branches of industry, and, from an industrial gas engineer's point of view, no specialised industries other, perhaps, than the production of whisky.

The Board's industrial gas tariff is shown in Table 1.

Load factor discounts of 5 or 10% are granted on the published prices, subject to compliance with the following conditions:

(1.) The quarterly consumption of gas must be at least 400 therms (89,000 cu.ft.).

(2.) The average monthly consumption over the year must be at least 90% of the maximum consumption in any one month during the peak period of the year. (An allowance will be made for factory holiday periods.)

TABLE 1.—Industrial thermal tariff.

Quarterly Consumption (Therms)		Rate, d. per Therm
First	33	30
Next	1,200	21
..	15,000	19
..	15,000	17½
..	500,000	15
Remainder over	531,233	14

By

A. HIGGS

M. Inst. Gas E., M. Inst. F.

Area Industrial Gas Sales Development Officer

&

R. W. DEANS

B. Sc., Assoc. M. Inst. Gas E.

Divisional Industrial Gas Sales Officer (Glasgow and Western)

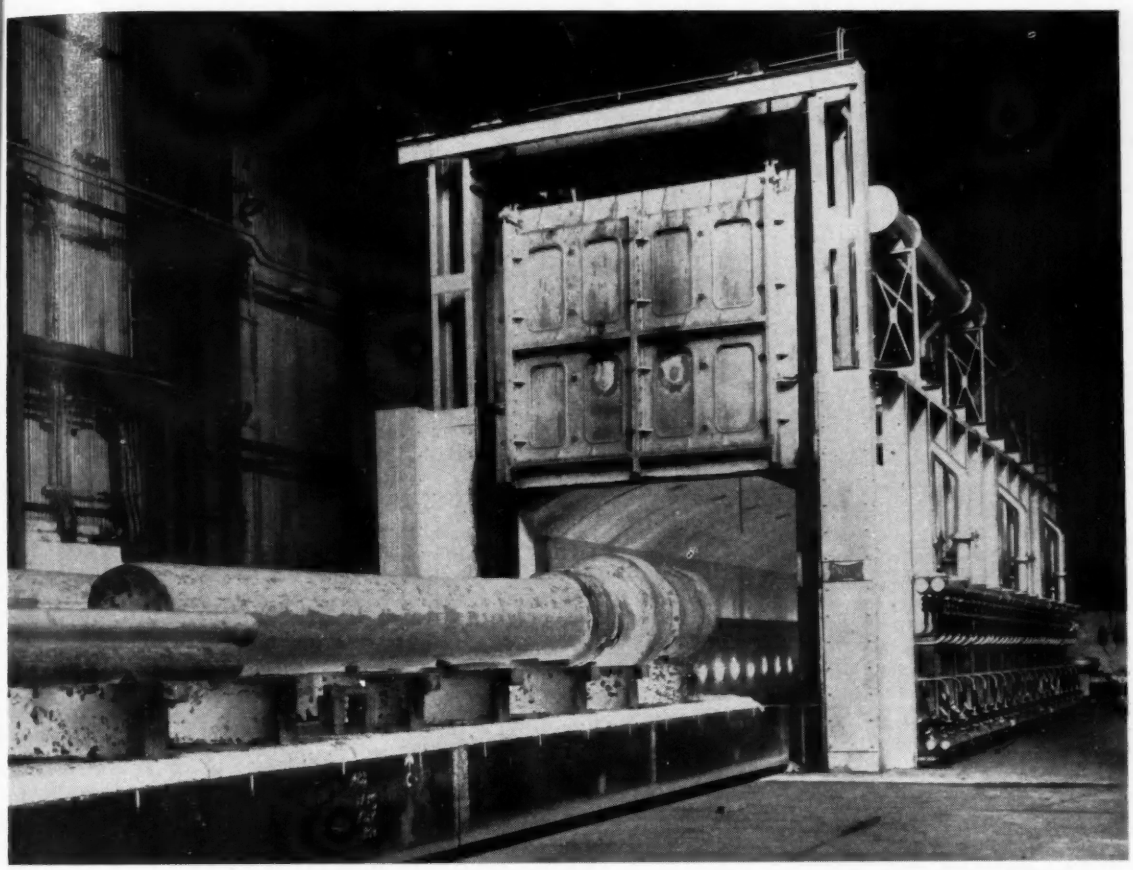
(3.) The demand for gas is for continuous process work and spread evenly throughout 24 hours per day. and seven days a week.

(4.) At least 50% of the daily demand is taken between 6 p.m. and 9 a.m.

Consumers who fulfil the qualifications (1.) and (2.), are entitled to a discount of 5% of the price of gas, while those who fulfil the qualifications (1.) and (2.) *and* either (3.) or (4.) are entitled to a discount of 10% of the price of gas.

The Board reorganised its industrial technical advisory service to industry in October, 1958. An area industrial gas officer was appointed, and is responsible to the Board for the development of industrial gas sales throughout Scotland. The industrial staff operate under his technical direction.

Supporting technical service to the divisions on special projects is arranged, as necessary, by the area officer, utilising the industrial staff



By courtesy of William Beardmore & Co., Ltd

FIG. 2. *Priest bogie hearth furnace.*

resources of the Glasgow and Western Division.

Industrial laboratory facilities are available, with provision for the testing of prototype industrial equipment involving a maximum gas rating of up to 20,000 cu.ft. per hour.

Fig. 1 shows a combustion chamber of a Cochran packaged boiler under test in the laboratory.

The divisions operate on a functionalised basis, and industrial gas sales are at present contained within the general sales function covered by the Divisional Controller of Sales in the Glasgow and Western Divisions, and the divisional sales and service managers in the other divisions.

The Glasgow and Western Division of the Board serves the more highly industrial areas, and in total serves some 2,138 industrial gas consumers. The establishment affords the solid background to the Board's industrial effort, providing a nucleus of skilled industrial engineers, district industrial representation, and an industrial drawing office with estimating and design sections and development laboratory facilities.

The other divisions each have a divisional industrial gas officer and either two or three industrial representatives. Industrial gas activities in all divisions are considered at the bi-monthly meetings of the Board's area commercial policy committee.

The first essential in formulating a planned approach to developing industrial business is an accurate assessment of the market. Such an assessment is progressing in Scotland and much valuable information has already been secured.

In the development of major potential loads, the initial contact is normally made with top-level technical management, and agreement secured to the carrying out of a survey of fuel preparation and process plant, and to the submission of proposals for conversion. The administrative procedure is designed to ensure that all projects are progressed with the minimum of delay, and each project being investigated is given a project number with basic data sheet for the guidance of the industrial engineer and laboratory staff responsible for carrying out the survey and tests.

The Board has agreed an allocation of £10,000, to be used at the discretion of the area industrial gas officer and divisional general managers, for the installation of equipment on 'sale or return' where such action is justified. Where this action is taken, a basis of acceptance is submitted and agreed by the consumer before the job proceeds.

The problem of industrial staff training confronts all Boards. Obviously, cumulative experience over a period of years is essential to provide the necessary background to convert the new 'graduate' or otherwise 'qualified entrant' into a technical sales engineer with the requisite commercial ability to exploit the industrial market, but much can be done by training courses to impart basic knowledge in respect of selection and layout of controls, and correct installation of plant. Recruitment to the industrial engineering staff is direct from universities and the Heriot-Watt College, Edinburgh, although a number of entrants have selected industrial gas as a career after having passed through the Board's graduate general training course. District industrial representa-

tives have, in general, been recruited from the gasfitting side, men with suitable personality and initiative and the necessary enthusiasm to continue their studies until qualified being chosen. A balance between the academically qualified entrant and the practical man is found to be most advantageous in practice.

A number of furnace manufacturers are prepared to assist area gas boards in specialised training by making available facilities to take a number of industrial trainees for three to six months. These resources are being used for industrial engineering staff.

Following the reorganisation of the Board's industrial staff structure and to ensure that all staff were uniformly briefed in the more common aspects of industrial gas engineering, a concentrated one-week course was organised in conjunction with the Educational and Training Officer at the Board's training centre.

The wholehearted co-operation and interest of the furnace-manufacturing industry has contributed substantially to the development of the industrial gas load in all areas. Many new techniques have been developed, and incorporated, in gas-fired plant. The increased use of insulating refractory in the construction of large heat-treatment plant, of improved multiple-burner systems and air:gas ratio control are more and more becoming standard features, materially assisting the development and retention of load.

Beardmore and Co., Ltd., of Parkhead, Glasgow, the well-known manufacturers of large steel forgings and steel castings, in infinite variety and of the highest quality for the shipbuilding, steel, and heavy engineering industries, is the Board's largest gas consumer, taking at the moment approximately 1,000 mill. cu.ft. per annum of gas.

With the increased demand for precision heat treatment, to condition large forgings for the more onerous duties to which they are subjected, new gas-fired plant is continuously being installed. The heat treatment of forgings, of up to 100 tons in weight, is a complex one calling for extreme uniformity in temperature distribution, often with a permissible tolerance of only $\pm 2\frac{1}{2}$°C. throughout the load. The ready facility with which town gas can be applied in accurately controlled quantities simultaneously by means of multiple burners enables these exacting requirements to be met.

This is perhaps well illustrated on two new bogie hearth furnaces built by Priest Furnaces, Ltd., of Middlesbrough. These furnaces have internal dimensions of 50 ft. deep by 12 ft. wide across the bogie by 10 ft. high, and 30 ft. deep by 10 ft. wide across the bogie by 10 ft. high respectively. Fig. 2 illustrates the larger of the two furnaces.

Multiple burners are fitted at high and low level, at relatively close centres, to afford the requisite heat input with independent control of top and bottom temperature. Variations in heat demand, occasioned by load, in a vertical direction, can, therefore, be compensated. The burners employed are of two types: Nozzle-mixing converging-tunnel horizontal-firing burners located at bogie top level, directing streams of high-velocity combustion products across the top of the bogie and under the load; and vertical burners of the luminous-flame type giving slow combustion and long flame travel and firing upwards adjacent to the side walls.

Control of temperature longitudinally is achieved in the large furnace by dividing it into three zones, and, in the small furnace, into two zones. The burner systems in these respective zones are manifolded separately to

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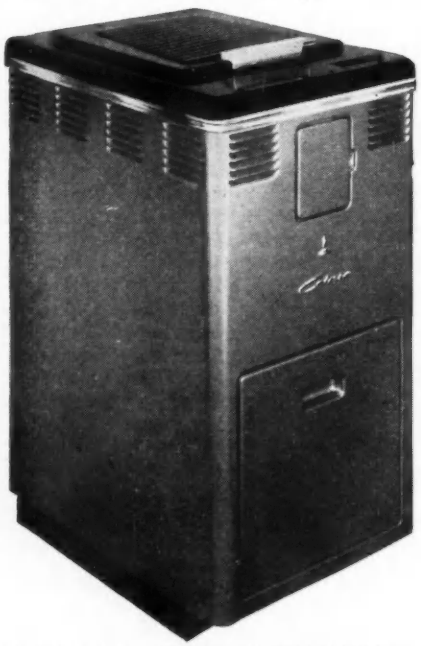

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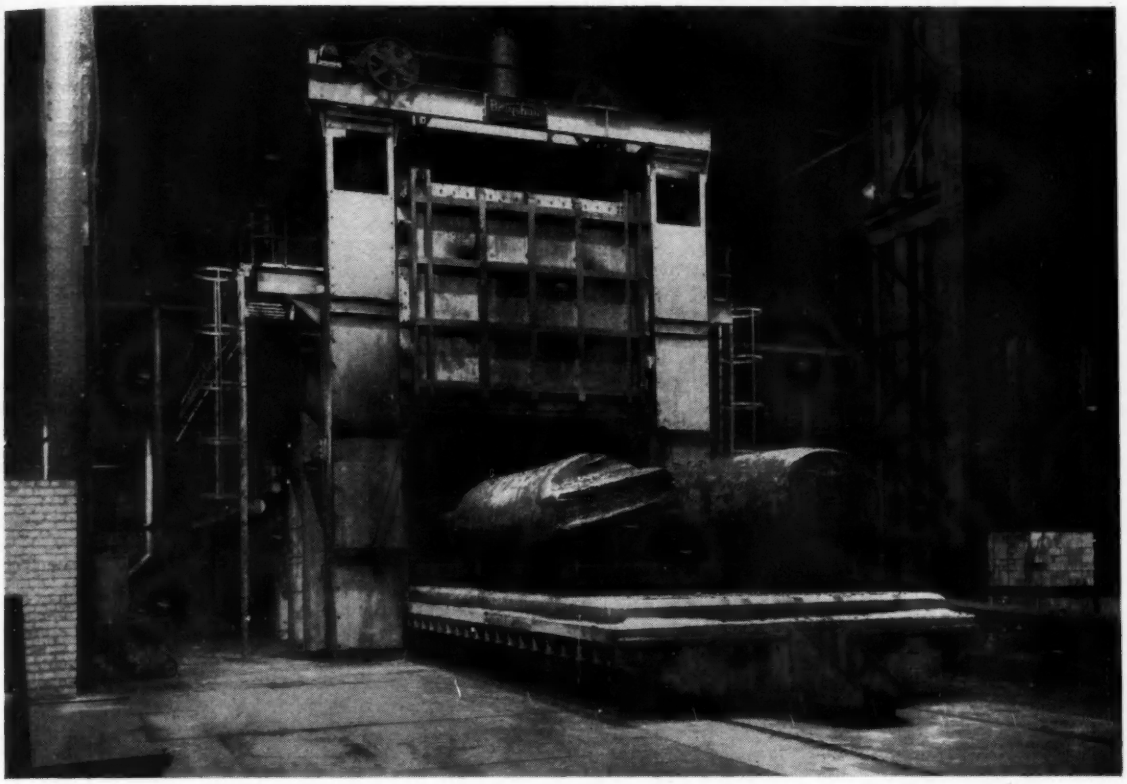

By courtesy of William Beardmore & Co., Ltd

FIG. 3. *Brayshaw forced convection bogie hearth furnace.*

afford independent top and bottom temperature control. Honeywell Brown automatic temperature controllers are employed to control the gas/air input to these separately manifolded burner assemblies.

Insulating refractory is used in all positions not subject to abrasion (that is, in the side walls and in the arches, back walls and doors), so that the general furnace structures have a low thermal capacity and are hence extremely responsive to changes in thermal input. A 'pressure' at hearth level, to prevent air infiltration, is maintained by a Honeywell Brown automatic pressure controller operating a 30-in. flue damper and sampling from multiple points located in the side walls at hearth level.

The maximum gas consumption of the larger Priest furnace is 50,000 cu.ft. per hour, and the furnace is capable of bringing a 150-ton load from cold to 950°C. in 12 hours. The rating of the smaller unit is 30,000 cu.ft. per hour with the ability to raise a 75-ton load from cold to 950°C. in 12 hours when necessary.

The larger furnace will hold a load in equilibrium at 700°C. with a gas consumption of approximately 5,500 cu.ft. per hour, and the smaller one will hold at similar temperature with a gas consumption of approximately 3,000 cu.ft. per hour. The ultimate annual load in this one department will be of the order of 300 mill. cu.ft.

Two other furnaces of original design have been installed by Beardmore for precision heat treatment at temperatures up to 950°C.

These two furnaces were constructed by Brayshaw Furnaces Ltd., of Manchester, and have internal dimensions similar to the Priest furnaces outlined previously. High-velocity forced convection is employed as the heating system, and, on the larger of the two bogie hearth furnaces, six hot gas recirculation fans are fitted on the roof of the furnace. Each fan is rated at 22,500 cu.ft. per minute of combustion products and air, and driven by a 30-h.p. motor.

The furnaces are substantially lined with insulating refractory, as also are the six fan casings and connecting ducts. The heat input is provided from an air-blast burner firing into a combustion chamber fitted on the intake to each recirculating fan. Electronic flame failure equipment is incorporated on the main and pilot burner assemblies, together with fan failure protection. The combustion products are discharged into the furnace chamber through a multiplicity of ports built into the side walls of the furnace, with provision for independent adjustment to facilitate 'balancing' of the furnace.

After passing through the load, the gases are withdrawn through apertures in the crown of the arch and return to the fan intakes. With the high rate of re-circulation provided for, a heat distribution within a tolerance of ± 1°C., is obtained. The smaller furnace is fitted with four recirculating fans, combustion chambers and individual burner assemblies, and both furnaces are fully instrumented by means of Honeywell Brown automatic temperature and pressure controllers, as in the case of the Priest furnaces. The maximum gas consumptions are 60,000 and 35,000 cu.ft. per hour respectively.

Other new furnaces under construction for William Beardmore and Co., Ltd., include large muffle units for the precision hardening and tempering of 7-ton rolls, suspended vertically.

To be continued

Factory Kitchens— continued from page 189

food and would include all fixtures, heavy furniture and equipment used in storage, preparation and cooking, service, washing up and waste disposal.

It is intended in the following example to take good quality equipment capable of standing up to the heavy wear and tear of commercial kitchen use for at least fifteen years.

Add to this amount a figure of, say, £500 for replacement of cooking pots, baking trays, preparation utensils and lighting fittings over the important preparation areas and a total of £5,000 to re-design and re-equip the kitchen is obtained. This, with an estimated life of fifteen years and cooking for 200 people per day for say 250 days every year, gives an allocated figure of 1.6 pence per meal.

Added to this will be servicing and replacement costs. Servicing of the cooking service, beverage and cold storage equipment would be in the region of £200 per annum and replacement of cooking pots and kitchen preparation utensils about £40. This adds £200 per annum to the costs, and works out at 1.15 pence per meal, making a total of 2.75 pence. This is the cost of re-designing and bringing up to date the average 150-200 meal factory or office restaurant kitchen.

The figures quoted are for good quality equipment. Some equipment can be expensive without necessarily being more efficient in any way at all. Some equipment could be lower priced without making any difference.

The dining room may need re-equipping, therefore the study of table and seating areas in relation to the overall available space is worth considering.

The long established eight to ten sq.ft. per person rates no longer need apply with modern back to back settle seating at tables for four persons and with central pedestal support instead of the conventional four legs. The seating area can be assessed at 6 sq.ft. per person. This allows greater seating capacity per meal service, if required. If this is not a pressing problem it is well to adhere to the conventional four chairs and table; these do have the merit of being moveable if the dining room is to be used for other purposes. Costs here are best left to local requirements, but as a general guide £2 10s. 0d. per seat and table area per person is sound basis to work upon.

Eric Ford—*from page 188*

gether, it is particularly important that they shall be kept warm during the night while the drying process takes place and judicious use of overhead heaters has proved an economical method of achieving this end.

All cooking in the well-appointed canteen providing meals for the company's 900 employees is done by gas and this is but one aspect of the firm's welfare facilities. Another is the commendable safety policy which is in force. So far as the use of gas is concerned, this shows itself not only in the extent to which flame failure and other recognised safety devices are incorporated in the gas-fired equipment but in the care which is taken to ensure that all operatives concerned are fully acquainted with the appropriate safe lighting-up drills and that these drills are at all times carried into effect.

In all its operations, the company makes extensive use of the gas supplied by the North Staffordshire Division of the West Midlands Gas Board and also of the services which accompany the supply of gas.

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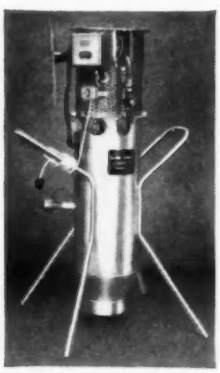

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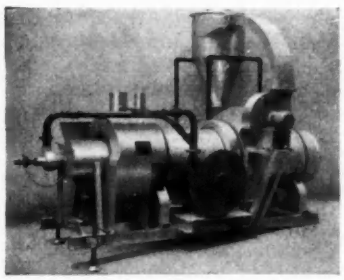

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